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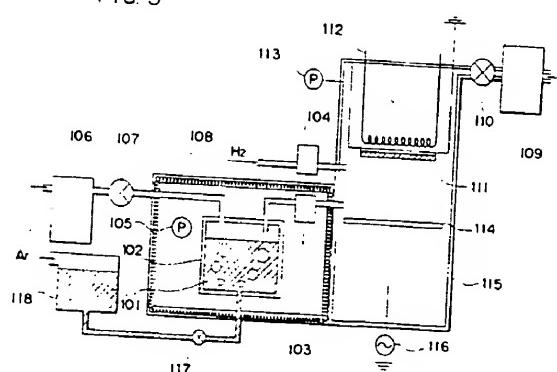
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#### **54 Chemical vapor deposition method and apparatus making use of liquid starting material**

(5) A starting gas feeding apparatus for forming a gaseous starting material from a liquid starting material and feeding the gaseous starting material into a reaction chamber of a CVD apparatus, comprises; a container that holds the liquid starting material

pressure reducing means for reducing the pressure inside the container, and heating means for heating the liquid starting material held in the container; the liquid starting material being boiled.

FIG. 5



ture, as exemplified by dimethylaluminum hydride (DMAH) and triisobutylaluminum (TIBA). For this reason, the bubbling, i.e. the step of generating bubbles in the bubbler 402 is carried out, so that a mixed gas comprised of the carrier gas and saturated vapor of organoaluminum compound such as DMAH is fed into the reaction chamber. The mixed gas is thermally decomposed on the heated semiconductor substrates 409, and aluminum is deposited on the substrate as a result of its surface reaction with the substrates.

Unreacted gas in the reaction chamber 403 is exhausted outside by means of the main pump 404 and auxiliary pump 405.

However, a change in apparatus environment such that an experimental CVD apparatus that has stably achieved the selective deposition is made up to a mass-production CVD apparatus has caused the problem that the selectivity having been achieved so far is lost.

This results in an increase in faults not only in the case of the metal films but also in the case of the semiconductor films, and results in a lowering of step portion coating properties in the case of the insulating films.

According to a finding made by the present inventors, the poor general-purpose properties is caused by the following reasons, as will be more detailed later, in the constitution of the conventional CVD apparatus.

First, the mixing ratio of the starting material liquid compound and other gas can only be very poorly controlled.

Second, a temperature change in the vicinity of the bubbler causes a change in the mixing ratio of the compound.

Third, residual gases in the bubbler cause a change in the mixing ratio of the compound.

#### SUMMARY OF THE INVENTION

An object of the present invention is to provide a chemical vapor deposition method and apparatus that can stably form deposited films with a good quality even if there are changes in environmental conditions or changes in operational parameters.

Another object of the present invention is to provide a chemical vapor deposition method and apparatus that has excellent operability and mass-productivity and promises the reduction of production cost of various devices fabricated.

Still another object of the present invention is to provide a chemical vapor deposition method and apparatus that can form deposited films that are uniform over a wide area, cause less unwanted faults and can be formed in good step portion coating properties.

The present invention provides an apparatus for forming a gaseous starting material from a liquid starting material and feeding the gaseous starting material into a reaction chamber of the CVD apparatus comprising:

5 a container that holds the liquid starting material, pressure reducing means for reducing the pressure inside the container, and heating means for heating the liquid starting material held in the container; the liquid starting material being boiled, and a CVD method making use of the apparatus.

10 The present invention also provides an apparatus for feeding a starting gas into a reaction chamber with starting gas feeding means and depositing a thin film on a substrate placed in the reaction chamber, wherein;

15 The starting gas feeding means comprises a heating apparatus comprising a heating member having a plurality of through-holes through which a starting gas is passed, temperature control means that controls the temperature of the heating member and a heater provided in the vicinity of the plurality of through-holes, controlled by the temperature control means; the starting gas being fed into the reaction chamber through the through-holes, and a CVD method making use of the apparatus.

20 The present invention still also provides a CVD apparatus comprising a container that holds a liquid starting material, a mixing chamber in which a gas of the starting material and other gas are mixed, a rectifier provided between the container and the mixing chamber; the rectifier being provided with gas feeding means comprising a plate member provided with an opening having heating means.

25 The present invention further provides a CVD apparatus comprising a head from which a starting gas is liberated toward a substrate placed in a reaction chamber; the head having a gas liberating surface at a distance of 10 mm or less from the surface of the substrate, and the gas liberating surface being detachably supported.

30 The present invention further provides a CVD apparatus for forming a deposited film comprised of the same material in a plurality of film forming regions, wherein;

35 The plurality of film forming regions are provided between them with means for turning a substrate, the substrate on which a film has been formed in one of the film forming regions is turned by an angle within the range of larger than 0° to smaller than 360°, and thereafter the substrate is placed in other film forming region to further form a film.

technical level to do so.

As shown in the above (3), the mixing ratio changes depending on the  $P_{DMAH}$ , and the  $P_{DMAH}$ , which is merely a saturated vapor pressure, changes depending on temperature. Fig. 4 shows the temperature dependence of DMAH on the saturated vapor pressure.

As shown therein, the  $P_{DMAH}$  exponentially changes with respect to temperature. On the other hand, since hydrogen is a gas at room temperature, the  $P_{H_2}$  does not exponentially change with changes of temperature. In other words, the molar mixing ratio greatly changes with changes of the temperature in the vicinity of the bubbler.

The hydrogen partial pressure  $P_{H_2}$  at the bubbler outlet does not coincide with the hydrogen pressure at the bubbler inlet, and has the relationship of:

$$P_{H_2(\text{out})} - P_{H_2(\text{in})} = c \cdot \rho \cdot h \quad (4)$$

wherein;

$P_{H_2(\text{out})}$  is a hydrogen partial pressure at the outlet of the bubbler;

$P_{H_2(\text{in})}$  is a hydrogen pressure at the inlet of the bubbler;

$\rho$  is a specific gravity of an organometallic compound;

$h$  is a distance from the tip of a bubbling nozzle to the liquid surface in a bomb; and

$c$  is a pressure calculating constant.

In this case, a variable that can be controlled by a regulator is only the  $P_{H_2(\text{in})}$ . Since, however, the value of  $h$  becomes smaller as the apparatus is used, the  $P_{H_2(\text{out})}$  changes. As a result, in order to keep the  $P_{H_2(\text{out})}$  constant, the  $P_{H_2(\text{in})}$  must be corrected according to the liquid remaining in the bubbler. However, this is a technique accompanied by a great difficulty because of the structure of the device. As detailed above, the conventional CVD apparatus can not be said to have a satisfactory starting gas controllability for the achievement of wide general-purpose properties and optimum deposition conditions.

According to the present invention, a starting material which is liquid at room temperature as exemplified by the organometallic compound is weighed at the stage where it is liquid, to control the amount of feed. Thereafter, the starting material is formed into particles or evaporated using a vibrator, a Venturi means or the like, heated before the reaction and then fed into the reaction chamber in the form of a gas. This constitution makes it possible to control the mixing ratio of carrier gas to other reaction gas at a high precision without influence by variations in saturated vapor pressure of the starting material.

Thus, according to the present invention, it becomes possible to appropriately carry out all types of CVD methods.

In the cases other than metal films, e.g., in the case of compound semiconductors, the compositional ratio of elements can be well controlled, and it becomes easy to form uniform semiconductor films or band gap controlled semiconductor films. In the case of insulating films, it becomes easy to control  $x$  or  $y$  in  $\text{Si}_x\text{O}_y$  or  $\text{Si}_x\text{N}_y$ , so that it becomes possible to form large-area films having a uniform dielectric constant.

In addition, it becomes possible to feed the starting material in a large quantity, and hence it becomes easy to uniformly form films on a large-area substrate or on a large number of substrates.

As the CVD starting material used in the present invention, a material that is liquid in a use environment of a CVD apparatus is used. More preferably it is a material that is liquid at room temperature, e.g. at 10 to 30°C. It may specifically include trimethylaluminum (TMA), triethylaluminum (TEA), triisobutylaluminum (TiBA), dimethylaluminum hydride (DMAH), diethylaluminum hydride (DEAH), monomethylaluminum hydride (MMAH), triethylindium (TEIn), trimethylindium (TMIn), trimethylgallium (TEGa), trimethylgallium (TMGa), dimethylzinc (DMZn), trichlorosilane ( $\text{SiHCl}_3$ ), silicon tetrachloride ( $\text{SiCl}_4$ ), tetraethyl orthosilicate (TEOS), fluorotriethoxysilane (FOTES),  $\text{POCl}_3$ ,  $\text{BBr}_3$ ,  $\text{Sn}(\text{CH}_3)_4$  and the like. In particular, organometallic compounds can be preferably used in the CVD method of the present invention because of their relatively low vapor pressure at room temperature and normal pressure and a difficulty in their feeding in a large quantity.

The reaction gas mixed with the above source material may include  $\text{H}_2$ ,  $\text{O}_3$ ,  $\text{NH}_3$ ,  $\text{NO}$ ,  $\text{N}_2$  and the like. An inert gas such as Ar may optionally be used.

Of course, when compound films are formed or the type of conductivity is controlled, a known doping gas as exemplified by  $\text{PH}_3$ ,  $\text{AsH}_3$ ,  $\text{BF}_3$ ,  $\text{B}_2\text{H}_6$ ,  $\text{SiH}_4$  or  $\text{Si}_2\text{H}_6$  may be used in combination.

The reaction chamber used in the present invention may be formed of an insulative reaction tube made of quartz or the like or a reaction tube made of a metal. The reaction tube used may be any of those capable of receiving therein at least one substrate on which a film is to be used.

An exhaust means may include a mechanical booster pump, a rotary pump, an oil-diffusion pump and a turbo-molecular pump, any of which can be used alone, or in appropriate combination.

The substrate is held in the reaction chamber by a substrate holding means in such a way that the deposition surface is set upwards, downwards,

given value, or the valve 107 is opened when it becomes more than another given value.

Other systems are also provided, e.g., a system for detecting abnormal discharge of plasma inside the reaction chamber and stopping the operation, and a system for detecting abnormal pressure inside the reaction chamber and stopping the operation.

The present invention can be applied not only to the CVD apparatus having the reaction chamber of sheet-by-sheet treatment as shown in Fig. 5 but also to a CVD apparatus having a reaction chamber of multi-sheet treatment according to a hot-wall system as shown in Fig. 1.

In the present invention, the exhaust systems 106 and 109 are separately provided in the apparatus shown in Fig. 5. Alternatively, the end of the valve 107 may be inserted between the valve 110 and the exhaust system 109 so that the exhaust system can be omitted.

In the apparatus shown in Fig. 5, two-system gas lines are connected to the container 102. Alternatively, the line having the exhaust system 106-107 may be omitted so that the inside of the container 102 can be evacuated through the reaction chamber 115 by means of the exhaust system 109.

As described above, as a method of feeding the liquid starting material for the CVD apparatus, the starting material vapor comprised of substantially 100% of the starting material is fed into the reaction chamber. Hence, it is weighed separately from other reaction gas and sent to the reaction chamber, where their mixing ratio can be maintained at a proper value and in a high precision, and also can be stably fed into the reaction chamber. Thus, it becomes possible to obtain a good film quality and film configuration of the deposit of the reaction product.

Incidentally, in an instance in which the saturated vapor pressure of the liquid starting material is so low that the deposition rate is determined by the amount of feed of the starting material, it is known to use the following apparatus as a method of improving feed efficiency of the starting material.

Fig. 6 is a diagrammatic illustration of a CVD apparatus used to form an aluminum thin film, which is disclosed in Japanese Patent Application Laid-open No. 2-38569.

A carrier gas 2002 is blown into a liquid starting material 2101 through a valve 2201 and a mass flow controller 2202, and a mixed gas of the carrier gas and starting gas is fed into a reaction chamber 2006. To the inlet of the mixed-gas, a rectifier 2003 is fitted so that the gases can be uniformly fed to the surface of a substrate. This rectifier makes it possible to increase the vapor pressure of the starting gas by heating a starting material tank

2001 by means of a heating mechanism 2103 when the liquid source material 2101 has a small vapor pressure. This rectifier 2003 is comprised of several rectifying plates 2302 for making gas flow uniform and a cylindrical frame 2301 to which the rectifying plates are fixed, and the cylindrical frame 2301 is provided with a built-in heater 2303. The heating mechanism 2103 of the starting material tank is set at a temperature high enough to increase the vapor pressure and also low enough not to cause the starting gas to decompose, e.g., about 50°C when an organometallic compound, triisobutylaluminum (TIBA), is used as the starting material. The heating mechanism belonging to the rectifier 2003 is set at about 230°C, which is a temperature at which the aluminum thin film is most fittingly formed.

Then, a substrate 2005 such as a silicon wafer fitted to a substrate holder 2004 is heated to about 400°C by means of a heating mechanism 2403, and as a result of thermal decomposition reaction of the mixed gas fed thereto the aluminum thin film is formed on the substrate.

Reference numerals 2601, 2602 and 2603 denotes respectively a valve 2601 for introducing the mixed gas, a valve 2602 for evacuation and a gate valve 2603 from which the substrate is carried in or taken out.

However, a change in apparatus environment such that an experimental CVD apparatus that has stably achieved the selective deposition is made up to a mass-production CVD apparatus has caused the problem that the selectivity having been achieved so far is lost.

This results in an increase in faults not only in the case of the metal films but also in the case of the semiconductor films, and results in a lowering of step portion coating properties in the case of the insulating films.

According to a finding made by the present inventors, these are caused by an insufficient starting gas temperature control made by the heating system.

#### Example 2

This Example is an improvement of the rectifier 2003 shown in Fig. 6, and has a structure that can form a gas flow having a uniform temperature distribution.

In the prior art previously described, the heater 2303 externally provided was used in order to maintain the temperature of the rectifier 2003 at, e.g., 80°C.

Fig. 7 is a graph to show the relationship between the temperature inside the rectifier 2003 and the feed efficiency of the starting gas formed by evaporation. When DMAH is used as the liquid

basis of signals outputted from a temperature sensor provided to the rectifying plate together with the heater 3307 as will be described layer.

In the case when the rectifying plate is provided in plurality, each heater and temperature sensor should be provided independently for each rectifying plate so that its fine adjustment can be made independently.

This heating rectifying plate 3306 is has a structure as shown in detail in Fig. 11. That is, a thick film of C, Cu, Ni, Ag, Pd or a high-melting metal such as Mo, Ta or W is formed as the heater 3307 on a ceramic substrate 3361 such as a boron nitride, alumina, zirconium, magnesia or cordierite substrate. To the both ends of the heater, terminal 3363 for power supply is provided, and is connected inside the fixing frame 3308 shown in Fig. 10. Reference numeral 3999 denotes temperature sensors provided arbitrarily in the area of the substrate. The ceramic substrate 3361 should be formed of boron nitride, having a large thermal conductivity. The upper layer of the heater 3307 thus formed is covered with an insulating ceramic material for the purpose of protection. Through-holes are further arranged for the purpose of gas rectification. In this example, the through-holes are made to have a size distribution so that the conductance at the outskirts where the flow velocity decreases can be increased.

Using this heating rectifying plate in plurality, plates having through-hole size distributions different from each other can be used so that the gas rectifying action can be improved.

A square or rectangular rectifying plate is shown in Fig. 11. It is also possible to symmetrically arrange the through-holes in a disklike substrate. Of course, a variety of heater patterns can be designed so long as the vicinities of the through-holes can be heated.

Reference numeral 4001 denotes external terminals of the temperature sensors, and 4002, external terminals of the heater. These are connected to the temperature control system 4000.

As another embodiment, as shown in Fig. 12, another ceramic substrate 3364 may be overlaid so that the heater is completely built in to give a top-and-bottom symmetrical structure.

The present Example thus constituted can achieve a uniform in-plane temperature distribution as shown by x marks in Fig. 9 previously given.

It also can achieve an improvement in temperature uniformity of the rectifying plate and also an improvement in the quality and thickness distribution of the film formed by CVD.

It still also can expand the scope of optimum conditions of gas heating temperature, flow rate and so forth, and at the same time can improve reproducibility to give films with a good coverage.

In addition, the use of the heating rectifying plates in a multiple construction to make individual temperature control expands the scope of adaptation for liquid starting material gas species used, the state of evaporation and so forth. It also brings about an increase in feed efficiency of the liquid starting material and an improvement in film deposition rate.

These effects can be great particularly when liquid source materials with a low saturated vapor pressure as in the organometallic compounds are used.

### Example 3

Fig. 13 is a diagrammatical illustration of a gas feeding system of the CVD apparatus according to this Example of the present invention.

Reference numeral 3006 denotes a reaction chamber, to which the substrate holder, the heater for heating substrates and so forth are provided in the same manner as in the embodiments previously described.

This reaction chamber 3006 is provided thereto with a mixing chamber 3100 via a connecting pipe, and the mixing chamber 3100 is provided beneath it with the same rectifier 3003 as in the Example previously described. Further beneath the rectifier, a starting material tank 3001 for holding a liquid starting material 3101, fitted with a heater 3103, is provided. The starting material tank is formed of quartz or a fluorine-treated insulating material.

On the side opposite to the reaction chamber side, the mixing chamber 3100 is connected to a carrier gas feeding means via a connecting pipe.

This carrier gas feeding means contains a mass flow controller 3202, a valve 3201 and a gas bomb 3203, and is further provided with a heater 3204.

This apparatus is operated as described below.

The liquid starting material 3101 kept in the source material tank 3001 is heated with the heater 3103 to generate vapor therefrom. The heating temperature at this time is selected from temperatures that can give a vapor pressure as large as possible without little causing decomposition of the starting material 3101. In the case of DMAH, the temperature may preferably be 40°C to 100°C. The pressure inside the mixing chamber 3100 is controlled to be about 0.5 to 200 Torr according to the conductance of the connecting pipes. As for the starting material tank 3001, its inside pressure is so made as to be 0.5 to 500 Torr by adjusting the size and density of the openings in the rectifying plate of the rectifier 3003. Stated specifically, the pressure inside the tank 3001 is made equal to the saturated vapor pressure of the starting material.

5006 and 5106.

For example, a material gas such as DMAH is fed into the first gas head assemblies 5007 and 5107 through a pipe 5017 and a reaction gas such as hydrogen is fed into the second gas head assemblies 5006 and 5106 through a pipe 5016. In the case when the gases are fed into the reaction chamber in the form of a mixed gas, the head assemblies and pipes may be unified.

The present CVD apparatus is operated as described below.

First, the substrate having been subjected to film formation on the holder 5001 while being reciprocated beneath the head 5005 is subsequently moved onto the turn table 5004. The turn table is turned by 180° by means of a motor 5003. Of course, it may be turned by any angle except 360° or 0°, and preferably 30° to 330°, and more preferably 30° to 210°.

Next, the substrate having been moved onto the holder 5002 is again subjected to film formation while being reciprocated similarly. These steps are carried out in the same reaction chamber 3006. Hence, with reference to Fig. 16, the right region A (5005A) of the substrate at the initial film formation corresponds to the left region B (5005B) at the subsequent film formation. Since the rate of film formation is determined by the flow rate of the starting gas in the case of DMAH or TiBA, the film formation should preferably be carried out independently in two or more film formation regions as in the present Example.

When the substrate is moved, there is a possibility that the film thickness becomes uneven substantially in parallel to the direction of movement. Now, in the present Example, the substrate is turned by the angle except 0° and 360° within the deposition area by means of the intermediating means having the turn table, and then the subsequent film formation is carried out. Hence, uniform films can be stably obtained.

Fig. 18 illustrates a modified embodiment of the present Example. Its film forming system is comprised of six heads 5005, 5105, 5205, 5305, 5405 and 5505, three holders 5001, 5002 and 5003 and two turn tables 5004 and 5014.

First, in a first film forming chamber DCA, the substrate is subjected to film formation on the holder 5001 while being reciprocated beneath the heads 5005 and 5105. Next, the substrate having been moved to a first intermediating chamber RCA is turned by 60° on the turn table 5004, and then moved to a next, second film forming chamber DCB. Film formation is also carried out here in the same manner as in the first film forming chamber DCA. Thereafter, the substrate is further turned by 60° in a second intermediating chamber RCB, and then moved in a third film forming chamber DCC,

where the film formation is again carried out.

Each chamber can be independently evacuated by means of an exhaust system 3605 so as to be isolated from the atmosphere. Gate valves (not shown) are also provided between chambers so that the film forming atmosphere can be independently maintained for each chamber.

Of course, including the turn tables, all the heads and substrate holders may be provided in a common chamber as shown in Fig. 16.

In order to improve mass-productivity, however, the multi-chamber system as shown in Fig. 18 should be taken and film formation is carried out in such a way that at least one substrate is always present in each film forming chamber.

Needless to say, the head in Example 4 may be employed in the heads 5005 and so on and, as the gas feeding system, the one used in Example 1 may be employed.

The present Example, in which the substrates are turned during the film formation, makes it possible to obtain uniform films with regularity and without unevenness.

## Experiment 1

Using the apparatus of Example 1, deposition of Al was carried out under typical conditions of a hydrogen flow rate of 500 sccm, a DMAH flow rate of 50 sccm, a reaction chamber pressure of 1.2 Torr and a substrate heating temperature of 270°C to form a metal film. As a result, the metal film obtained was an aluminum thin film with an excellent flatness and film quality.

## Experiment 2

On the substrate having the Al film obtained in Experiment 1, a silicon oxide film was formed using the CVD apparatus having the same constitution as in Example 1.

A silicon oxide film of about 1 μm thick was formed using TEOS as a starting material and ozone (O<sub>3</sub>) as a reaction gas. The silicon oxide film obtained well covered the step portion and was flat.

## Experiment 3

An aluminum thin film was formed using the apparatus of Example 2 described above and using TiBA as a source material and Ar as a carrier gas. As a result, the scope of conditions suited for film formation expanded in respect of the flow rate of the starting gas and the temperature of the gas feeding assembly. A good reproducibility was achieved, and it was possible to well feed the starting gas.

4. A CVD method for forming a deposited film on the substrate, making use of the apparatus according to claim 2.
5. The CVD method according to claim 4, wherein an alkylaluminum hydride is used as the starting material, which is reacted with hydrogen to form a metal film mainly composed of aluminum, on the surface of a conductor or semiconductor of the substrate. 5
6. A CVD apparatus for feeding a starting gas into a reaction chamber with starting gas feeding means and depositing a thin film on a substrate placed in said reaction chamber, wherein:  
said starting gas feeding means comprises a heating apparatus comprising a heating member having a plurality of through-holes through which a starting gas is passed, temperature control means that controls the temperature of said heating member and a heater provided in the vicinity of said plurality of through-holes, controlled by said temperature control means; said starting gas being fed into said reaction chamber through said through-holes. 10
7. The CVD apparatus according to claim 6, wherein said starting gas comprises an organometallic compound. 15
8. A CVD method for forming a deposited film on the substrate, making use of the apparatus according to claim 6. 20
9. The CVD method according to claim 8, wherein an alkylaluminum hydride is used as the starting gas, which is reacted with hydrogen to form a metal film mainly composed of aluminum, on the surface of a conductor or semiconductor of the substrate. 25
10. A CVD apparatus comprising a container that holds a liquid starting material, a mixing chamber in which a gas of said starting material and other gas are mixed, a rectifier provided between said container and said mixing chamber; said rectifier being provided with a gas feeding means comprising a plate member provided with an opening having heating means. 30
11. A CVD apparatus comprising a head from which a starting gas is liberated toward a substrate placed in a reaction chamber; said head having a gas liberating surface at a distance of 10 mm or less from the surface of said substrate, and said gas liberating surface being 35
- detachably supported. 40
12. A CVD apparatus for forming a deposited film comprised of the same material in a plurality of film forming regions, wherein;  
said plurality of film forming regions are provided between them with means for turning a substrate, the substrate on which a film has been formed in one of said film forming regions is turned by an angle within the range of larger than 0° to smaller than 360°, and thereafter said substrate is placed in other film forming region to further form a film. 45
- 50
- 55

FIG. 1

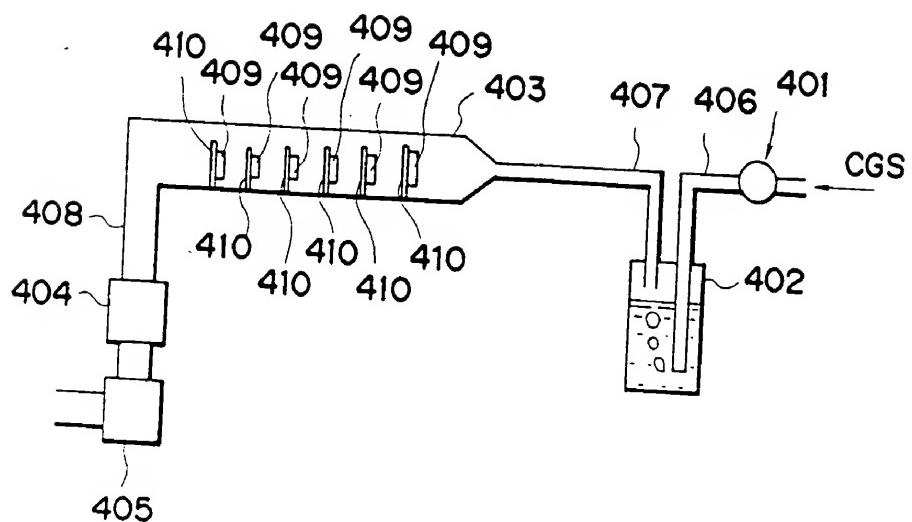


FIG. 2A

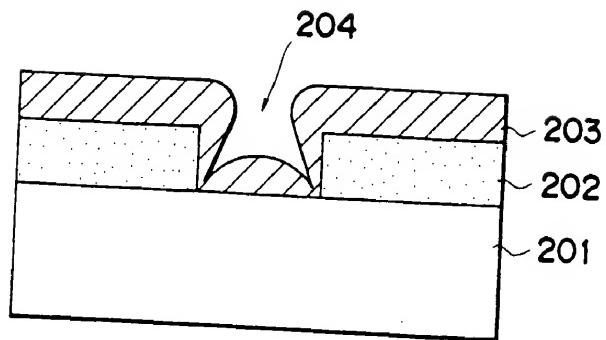


FIG. 2B

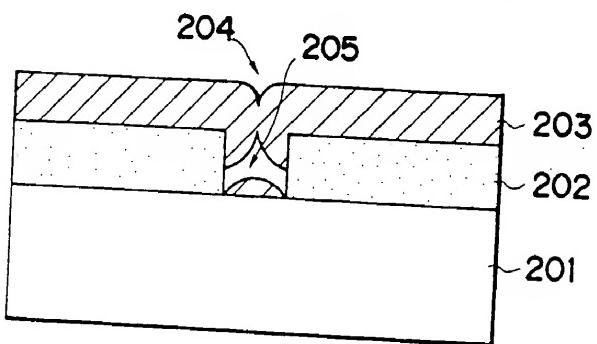


FIG. 2C

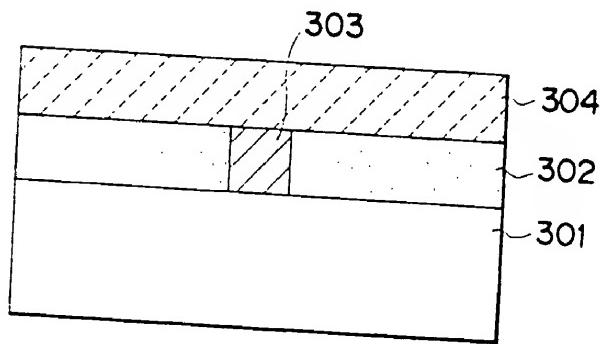


FIG. 3

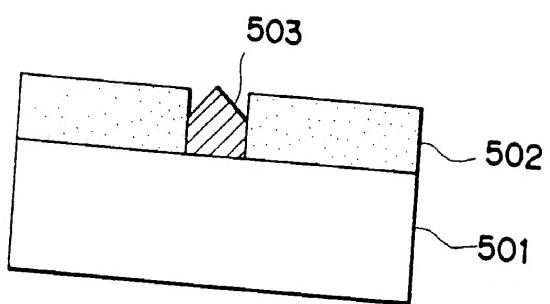


FIG. 4

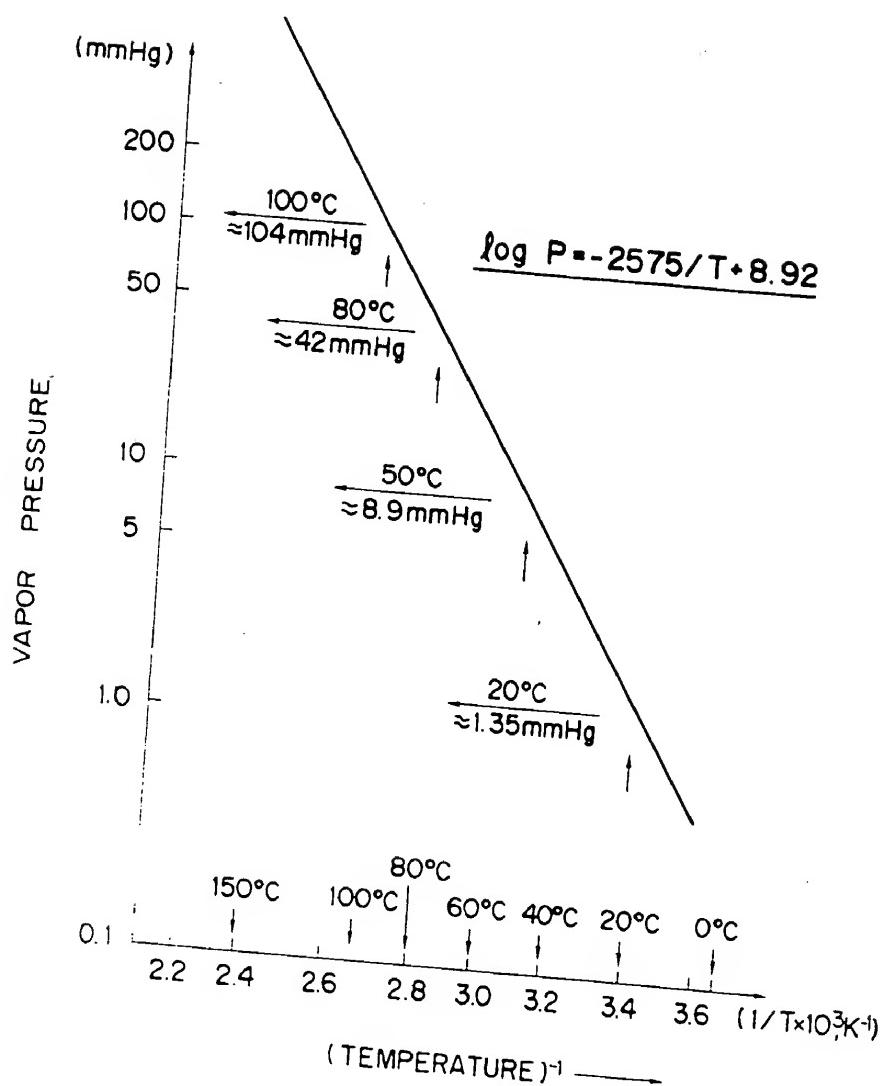


FIG. 5

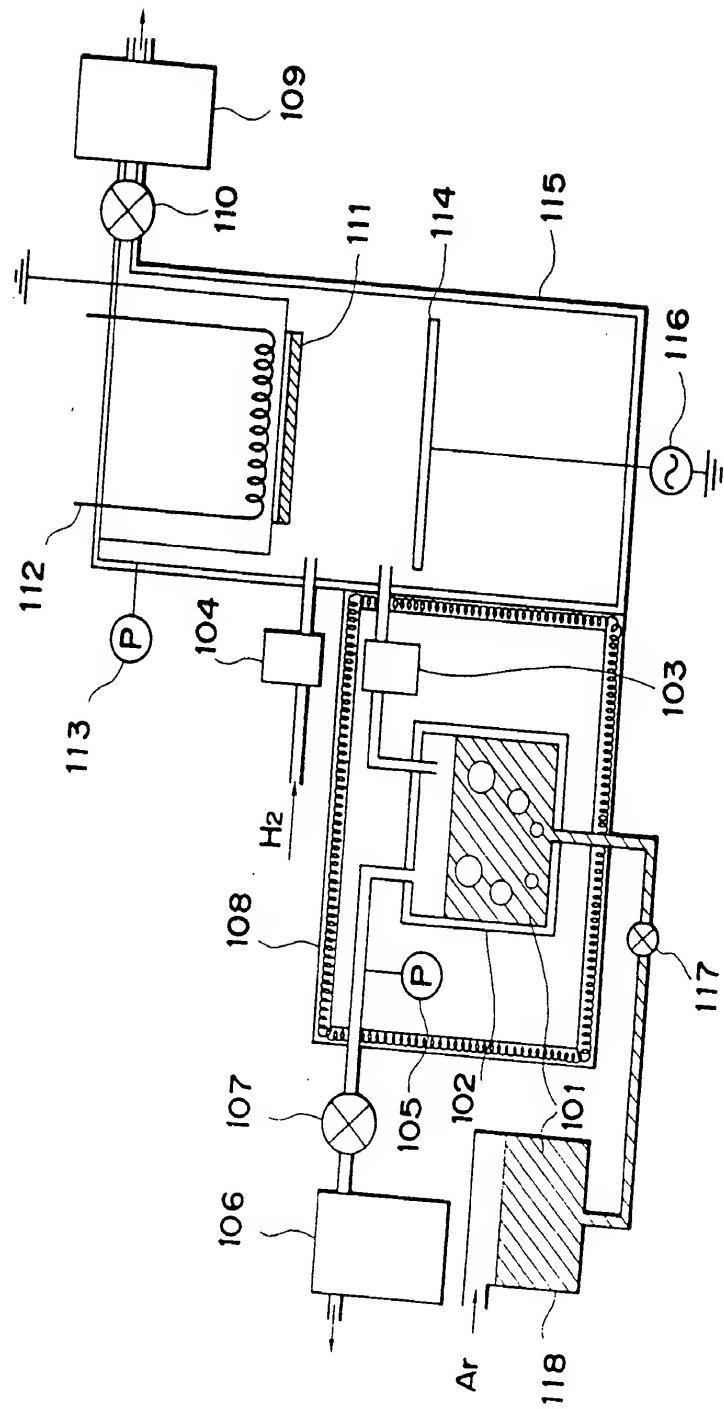


FIG. 6

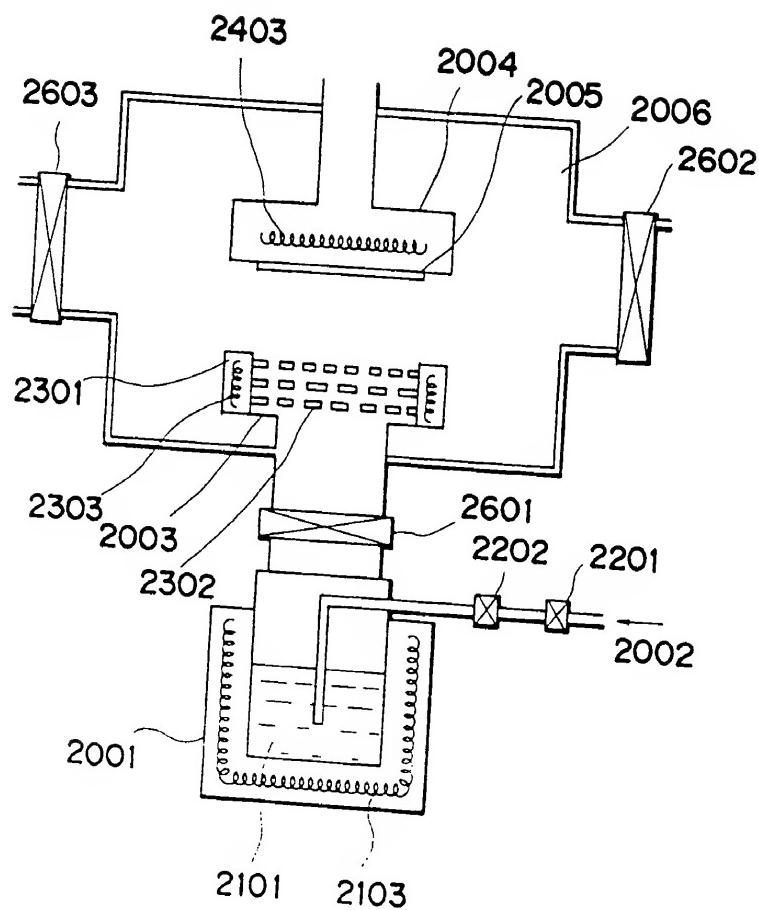


FIG. 7

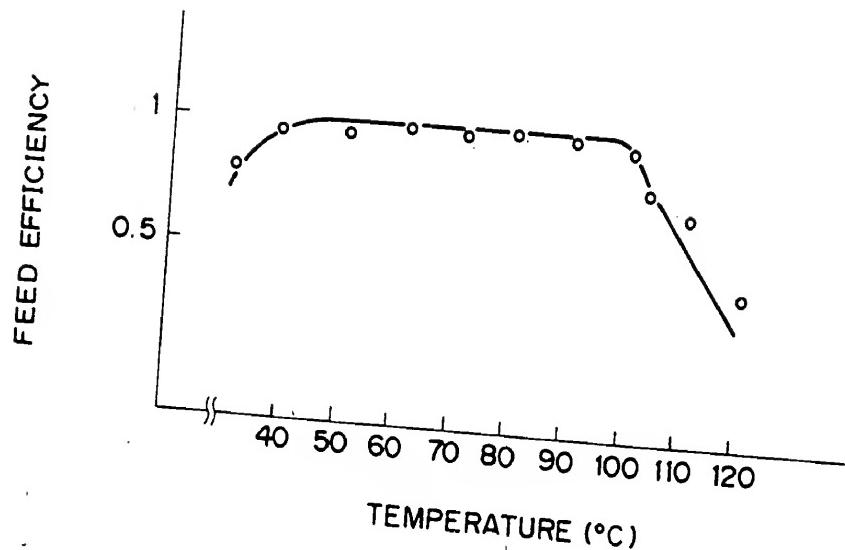


FIG. 8

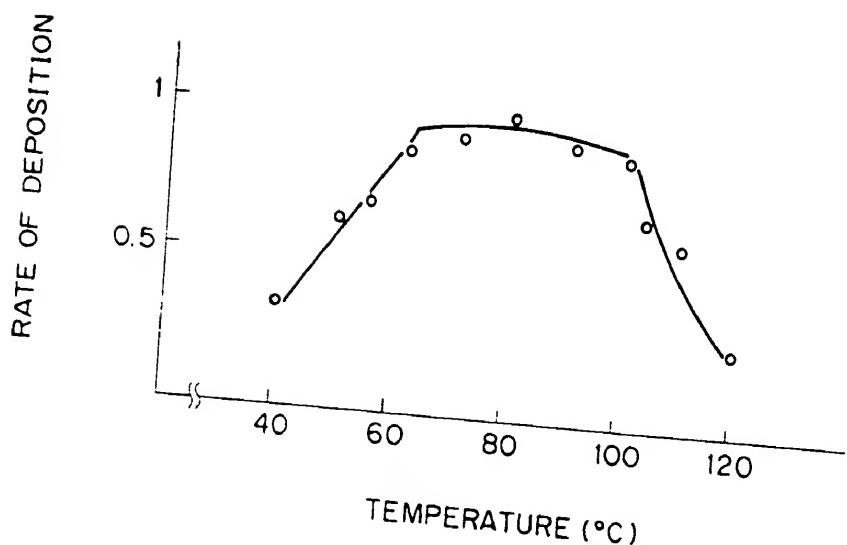


FIG. 9

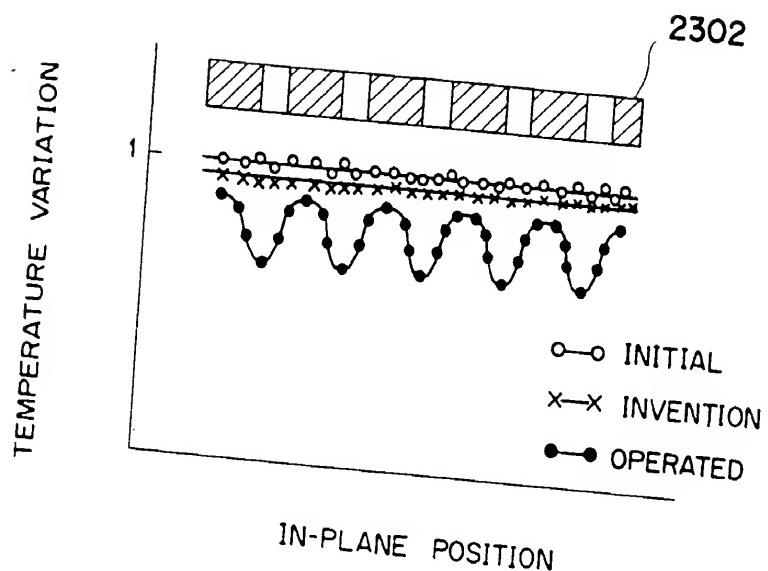


FIG. 10

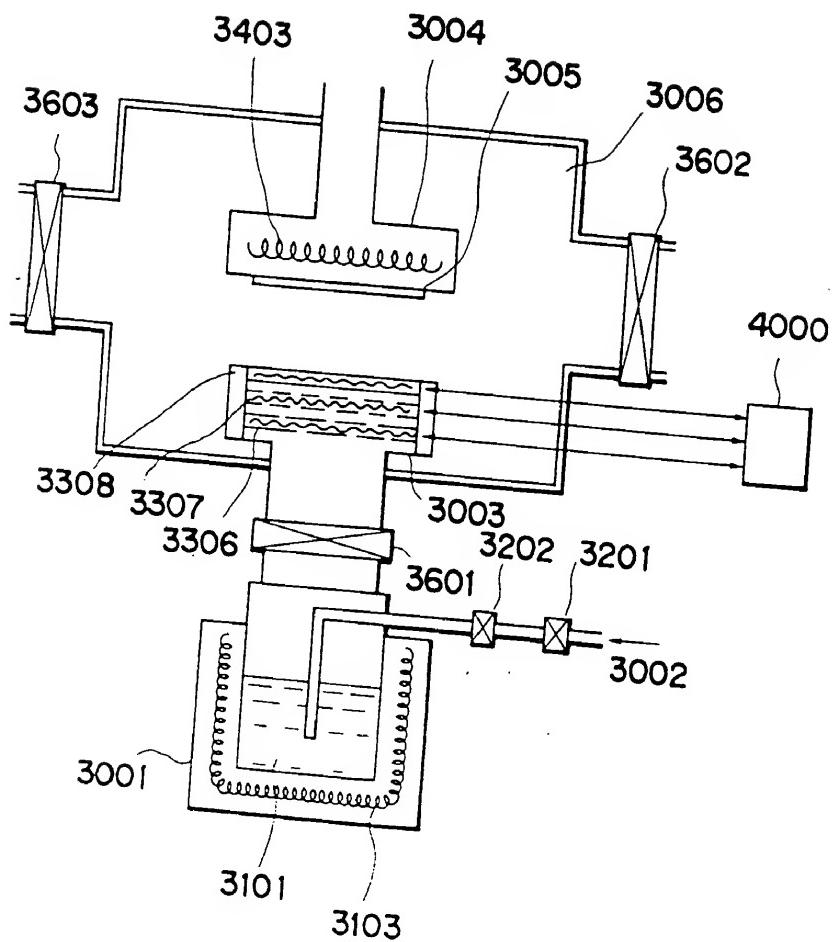


FIG. 11

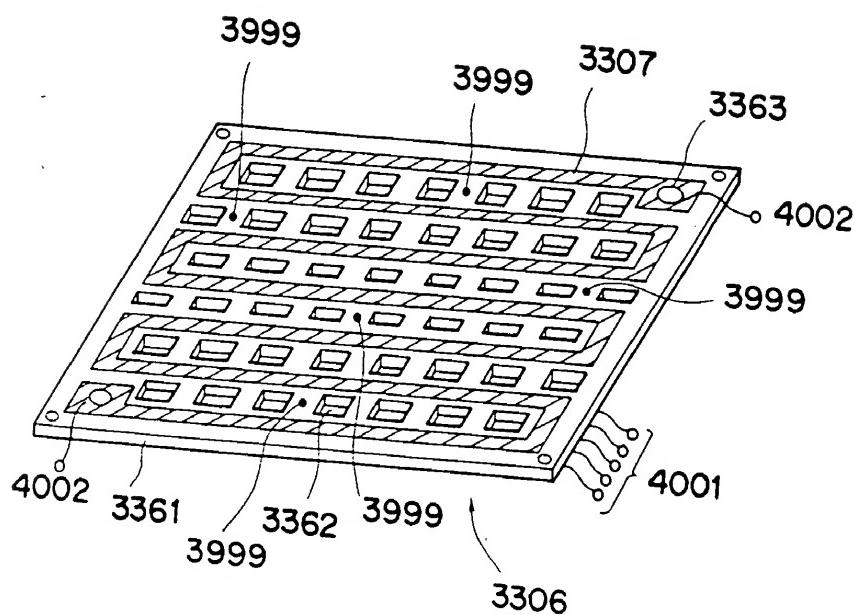


FIG. 12

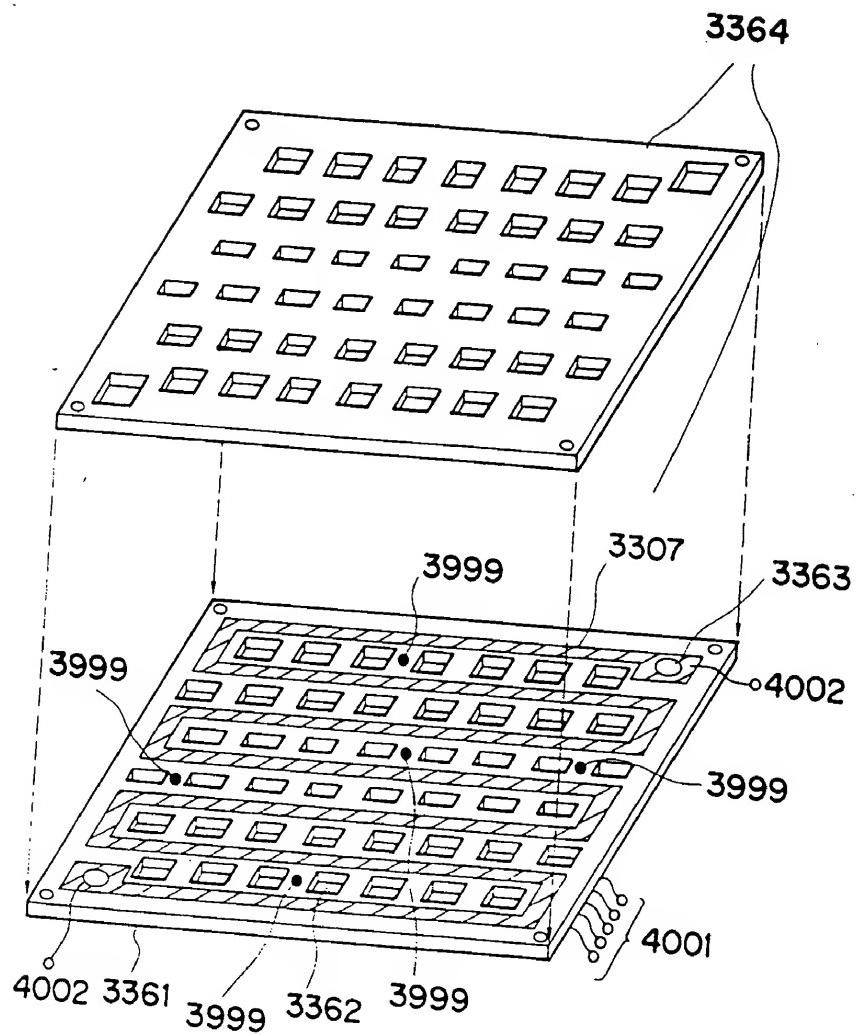


FIG. 13

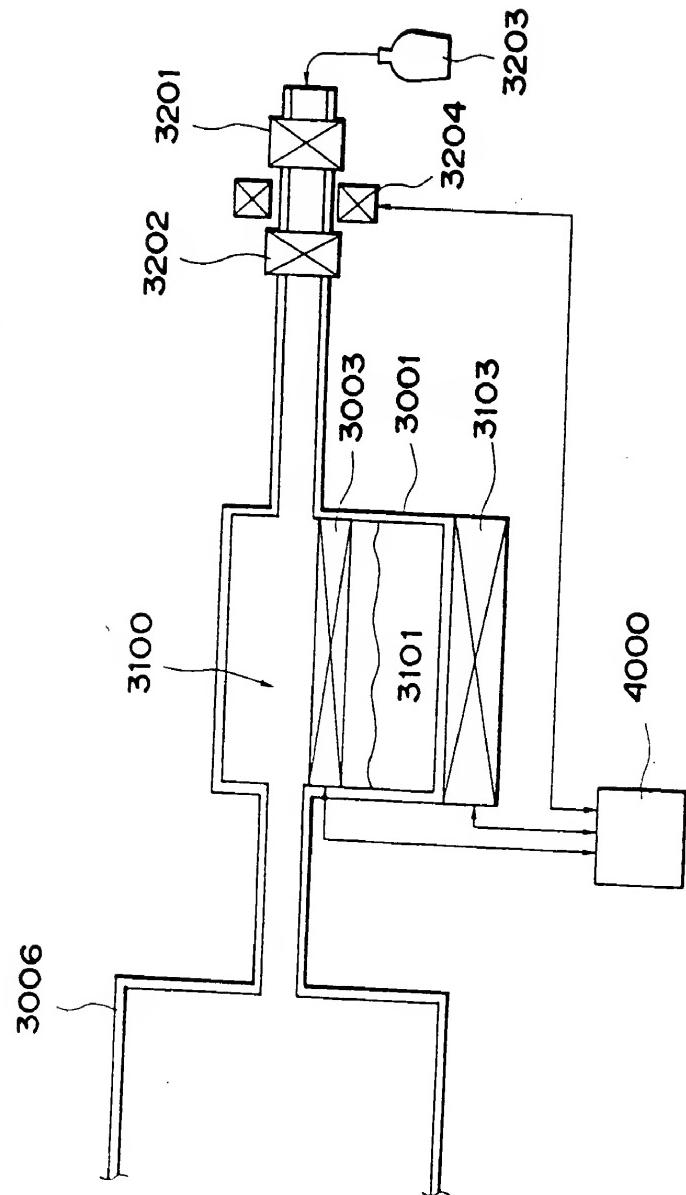


FIG. 14

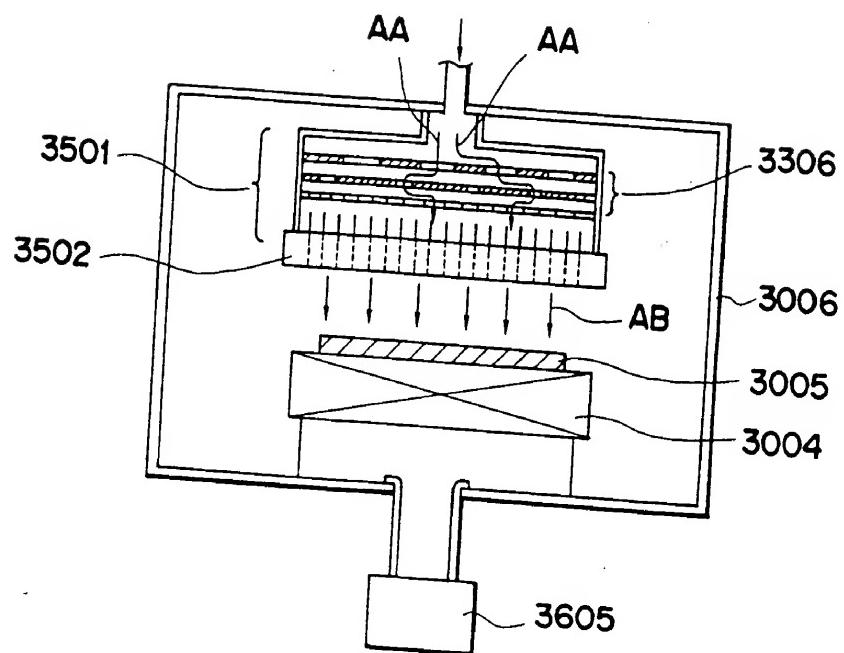


FIG. 15

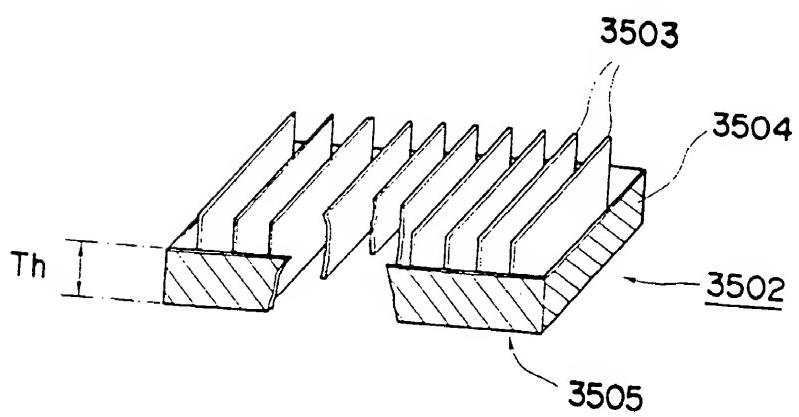


FIG. 16

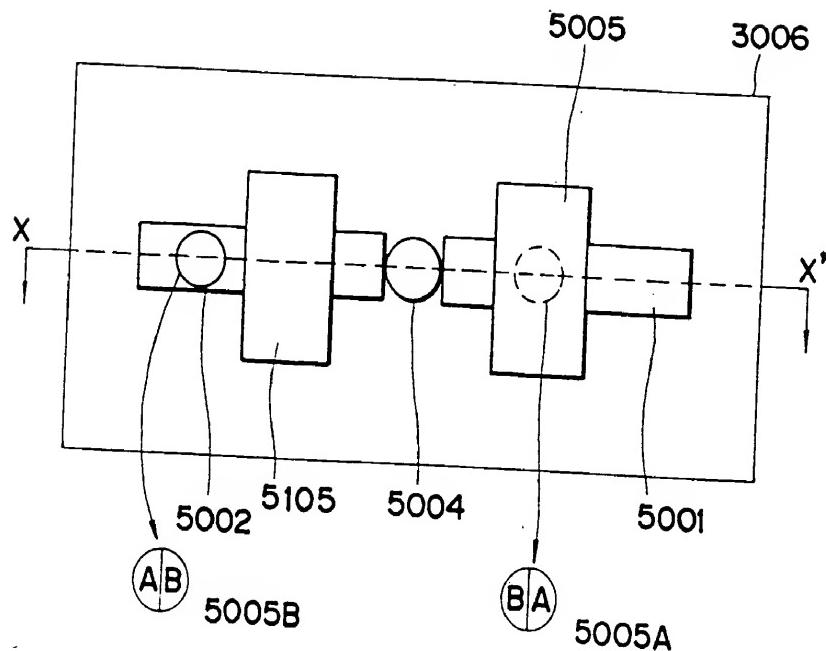


FIG. 17

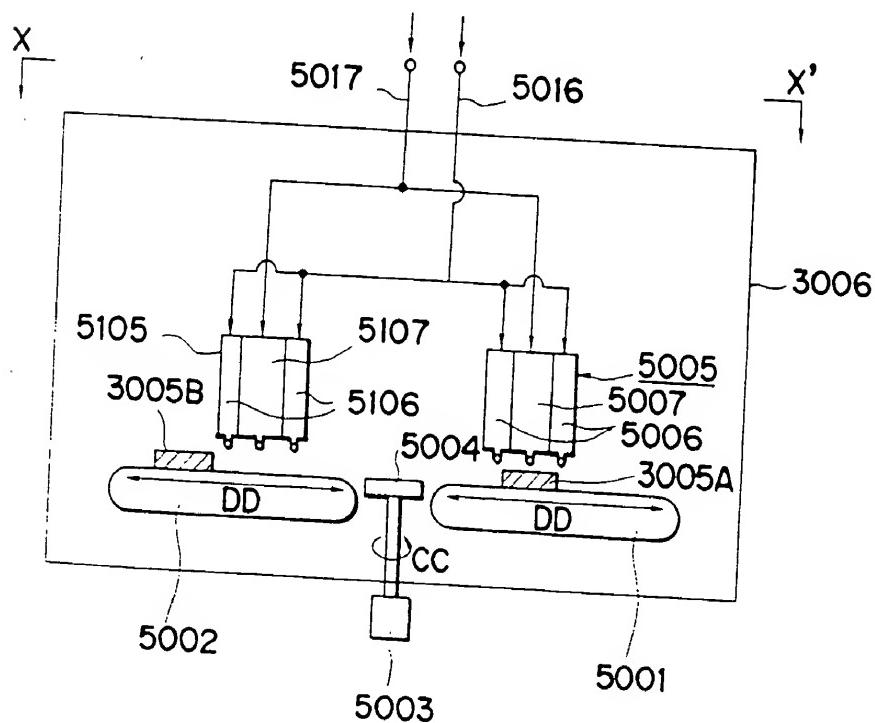
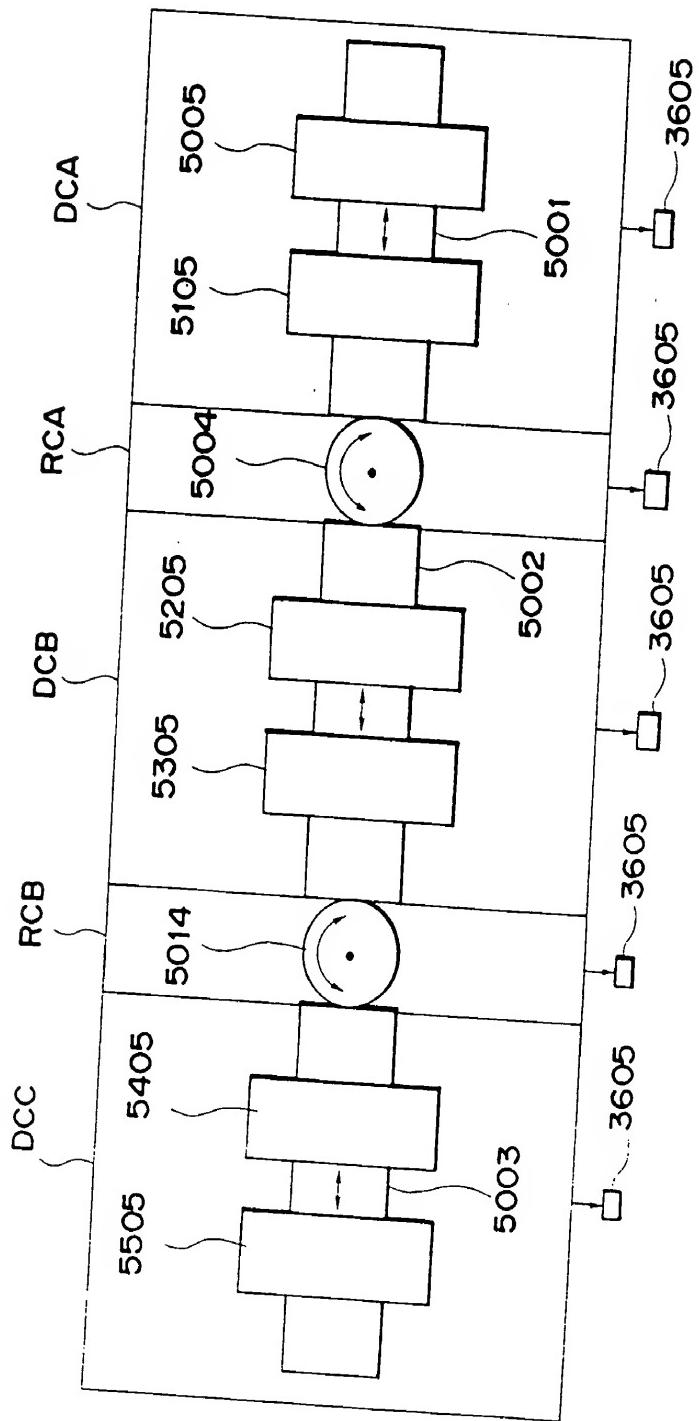


FIG. 18





European Patent  
Office

# EUROPEAN SEARCH REPORT

Application Number

DOCUMENTS CONSIDERED TO BE RELEVANT			EP 92121888.9			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 5)			
A	GB - A - 2 195 663 (NIPPON TELEGRAPH AND TELEPHONE CORPORATION) * Abstract; fig. 1; page 4, lines 15-42; claims 1-16 *	1-12	C 23 C 16/44 C 23 C 16/18			
A	EP - A - 0 435 088 (APPLIED MATERIALS JAPAN, INC.) * Abstract; fig. 1; claims 1-10 *	1-12				
A	EP - A - 0 419 939 (STEC INC.) * Abstract; fig. 1; column 5, line 30 - column 7, line 10; claims 1-15 *	1-12				
A	EP - A - 0 382 987 (L'AIR LIRUIDE, SOCIETE ANONYME POUR L'ETUDE ET L'EXPLOITATION DES PROCEDES GEORGES CLAUDE) * Abstract; fig. 1,2; column 1, line 1 - column 3, line 48; claims 1-7 *	1-12				
A	WO - A - 90/12 900 (ASM EUROPE B.V.) * Abstract; fig.; claims 1-8 *	1-12	C 23 C			
<p>The present search report has been drawn up for all claims</p> <table border="1"> <tr> <td>Place of search VIENNA</td> <td>Date of completion of the search 12-03-1993</td> <td>Examiner HAUK</td> </tr> </table>				Place of search VIENNA	Date of completion of the search 12-03-1993	Examiner HAUK
Place of search VIENNA	Date of completion of the search 12-03-1993	Examiner HAUK				
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, not published on, or after the filing date D : document cited in the application L : document cited for other reasons &amp; : member of the same patent family, corresponding document</p>						